Haoxuan Chen

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EDUCATION

Peking University Sep 2015-July 2020
Ph. D. Candidate, Environmental Science GPA: 3.6/4
Advisor: Prof. Maosheng Yao
Dissertation topic: Real-time online monitoring of air toxicity based on exhaled biomarkers

China Agricultural University Sep 2011-July 2015
B.S., Environmental Engineering GPA: 3.8/4

RESEARCH INTERESTS

Bioaerosol: Exposure risk assessment; Sampling and online monitoring; Bioaerosol transmission and source apportionment; Antibiotic resistance genes (ARGs);
Air pollution: Health effect and toxicity of PM; Contribution of components to PM toxicity; PM toxicity monitoring and analyzing methods;
Microbiome: Environmental microbiome; Microbial metabolomics; Human Microbiome; Interactions between PM exposure and microbiome community in respiratory tract;

HONORS & AWARDS

2019.10 Presidential Scholarship, Peking University (the highest scholarship in Peking University)
2019.10 Exceptional Award for Academic Innovation, Peking University
2018.10 National Scholarship for PhD Students, the Chinese Ministries of Education and Finance
2016.11 Best Poster Award at the 2016 World Life Science Conference
2016.10 Outstanding Student Award, Peking University
2015.06 Beijing Outstanding Graduates, Beijing Municipal Commission of Education
2012.10 National Scholarship for Undergraduates, the Chinese Ministries of Education and Finance

RESEARCH SKILLS

Microbiological and biochemical methods:

Bacteria and fungi culturing; DNA and RNA extraction; Quantitative polymerase chain reaction (qPCR); 16S rDNA clone library construction, sequencing and sequence analysis; Enzyme linked immunosorbent assay (ELISA), Endotoxin and (1→3)-ß-D-glucan detection; LIVE/DEAD BacLight method with fluorescent microscope observation.

Sampling techniques and instruments:

Aerosol generation and sampling (filtration, impaction and impingement) techniques; Aerosol monitoring instruments, such as OPC, UV-APS, WIBS, etc; Exhaled breath condensate sampling; Canister sampling for gas pollutants; Atmospheric pressure cold plasma generation technique;

Chemical methods:

Gas or liquid chromatography-mass spectrometric analysis; Dithiothreitol (DTT) assay;

Toxicological experiments:

Mice and rats breeding; Exposure methods: nasal drip, aerosol inhalation, blood injection; Blood sampling and exhaled breath condensate collection; Histopathological analysis;

PUBLICATIONS

1. **Haoxuan Chen**, Xinyue Li, Maosheng Yao* (2019), Rats Sniff off Toxic Air. *Environmental Science & Technology*, under review; *BioRxiv* version: https://doi.org/10.1101/739003.
2. **Haoxuan Chen**, Xiangyu Zhang, Ting Zhang, Xinyue Li, Jing Li, Yang Yue, Minfei Wang, Yunhao Zheng, Hanqing Fan, Jing Wang, Maosheng Yao* (2019), PM Toxicity Regulates Specific MicroRNA Levels, *Environmental Science & Technology*, under review.
3. **Haoxuan Chen**, Jing Li, Xiangyu Zhang, Xinyue Li, Maosheng Yao*, Gengfeng Zheng*, (2018), Automated *in Vivo* Nanosensing of Breath-Borne Protein Biomarkers, *Nano Letters*, 18(8), 4716-4726. DOI: 10.1021/acs.nanolett.8b01070. (IF: 12.279)
4. Yang Yue, **Haoxuan Chen** (co-first author), Ari Setyan, Miriam Elser, Maria Dietrich, Jing Li, Ting Zhang, Xiangyu Zhang, Yunhao Zheng, Jing Wang*, Maosheng Yao* (2018), Size-Resolved Endotoxin and Oxidative Potential of Ambient Particles in Beijing and Zürich, *Environmental Science & Technology*, 52(12), 6816-6824. DOI: 10.1021/acs.est.8b01167. (IF: 7.149)
5. **Haoxuan Chen**, Maosheng Yao* (2018), A High-flow Portable Biological Aerosol Trap (HighBioTrap) for Rapid Microbial Detection, *Journal of Aerosol Science*, 117, 212-223. DOI: 10.1016/j.jaerosci.2017.11.012. (IF: 2.24)
6. Jing Li, **Haoxuan Chen**, Xiangyu Zhang, Junji Cao*, Fangxia Shen, Yan Wu, Siyu Xu, Hanqing Fan, Guillaume Da, Rujin Huang, Jing Wang, Chak K. Chan, Alma Lorelei de Jesus, Lidia Morawska, Maosheng Yao* (2019), Differing toxicity of ambient particulate matter (PM) in global cities, *Atmospheric Environment*, 212, 305-315. DOI: 10.1016/j.atmosenv.2019.05.048. (IF: 4.012)
7. Ting Zhang, Xinyue Li, Minfei Wang, **Haoxuan Chen**, Ying Yang, Qinglin Chen, Maosheng Yao* (2019), Time-resolved Spread of Antibiotic Resistance Genes in Highly Polluted Air, *Environment International*, 127, 333-339. DOI: 10.1016/j.envint.2019.03.006. (IF: 7.943)
8. Ting Zhang, Xinyue Li, Minfei Wang, **Haoxuan Chen**, Maosheng Yao* (2019), Microbial Aerosol Chemistry Characteristics in Highly Polluted Air, *Science China Chemistry*, 62(1674-7291), 1051. DOI: 10.1007/s11426-019-9488-3. (IF: 6.085)
9. Yunhao Zheng, **Haoxuan Chen**, Maosheng Yao*, Xiaoguang Li* (2018), Bacterial Pathogens were Detected from Human Exhaled Breath Using a Novel Protocol, *Journal of Aerosol Science*, 117, 224-234. DOI: 10.1016/j.jaerosci.2017.12.009. (IF: 2.24)
10. Xiangyu Zhang, Jingjing Kang, **Haoxuan Chen**, Maosheng Yao*, Jinglin Wang* (2018), $PM_{2.5}$ Meets Blood: *in vivo* Damages and Immune Defense, *Aerosol and Air Quality Research*, 18, 456-470. DOI: 10.4209/aaqr.2017.05.0167. (IF: 2.735)
11. Yunhao Zheng, Jing Li, **Haoxuan Chen**, Ting Zhang, Xinyue Li, Minfei Wang, Maosheng Yao* (2018), Bioaerosol Research: Yesterday, Today and Tomorrow (in Chinese), *Chinese Science Bulletin*, 63(10), 878-894. DOI: 10.1360/N972018-00121.

PATENTS

1. Maosheng Yao, **Haoxuan Chen**, Xinyue Li (2018) A High Flow Aerosol-to-hydrosol Sampler. Patent #: 201820467598.9 (Issued).
2. Maosheng Yao, **Haoxuan Chen** (2017) A Portable High Flow Air Sampler. Patent #: 201621365479.X (Issued).
3. Maosheng Yao, **Haoxuan Chen** (2018) A Real-time Exhaled Biomarker Detection System and Method. Patent #: 201810052566.7 (In Disclosure).
4. Maosheng Yao, **Haoxuan Chen** (2017) A Portable High-flow and High-enrichment Bioaerosol Liquid Phase Collection Method. Patent #: 201710307307.X (In Disclosure).

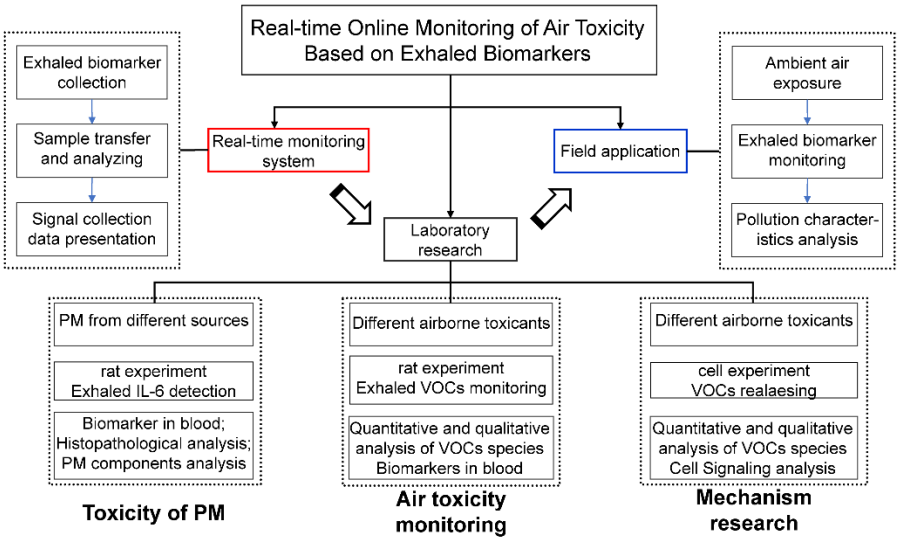
ORAL PRESENTATIONS

1. **Haoxuan Chen**, Xiangyu Zhang, Ting Zhang, Xinyue Li, Jing Li, Yang Yue, Minfei Wang, Yunhao Zheng, Hanqing Fan, Jing Wang, Maosheng Yao*, #21-S8, Acute Health Effects of Particulate Matter from Different Countries When Entering the Blood Circulation, The 10th National Conference on Environmental Chemistry (August 2019, Tianjin, China)
2. **Haoxuan Chen**, Jing Li, Xiangyu Zhang, Xinyue Li, Maosheng Yao*, Gengfeng Zheng*, Automated *in Vivo* Nanosensing of Breath-Borne Protein Biomarkers, The 4th China Bioaerosol Conference (May 2019, Nanjing, China)
3. **Haoxuan Chen**, Maosheng Yao*, #14.BA.6, Use of GREATpa System for Online Detection of Airborne Endotoxin, International Aerosol Conference (September 2018, St. Louis, USA)
4. **Haoxuan Chen**, Maosheng Yao*, #PS0230, Design and Evaluation of a High-flow Portable Microbial Aerosol Sampler, Asian Aerosol Conference (July 2017, Jeju, Korea)
5. **Haoxuan Chen**, Yunhao Zheng, Maosheng Yao*, Xiaoguang Li*, Detection of Biological Particles in Exhaled Breath of Patients with Respiratory Infection, Chinese Society of Particuology 9th Annual Conference (August 2016, Chengdu, China)

POSTER PRESENTATIONS

1. **Haoxuan Chen**, Maosheng Yao*, #P1-129, Acute Health Effects of Particulate Matter from Different Countries When Entering the Blood Circulation, Asian Aerosol Conference (May 2019, Hong Kong, China)
2. **Haoxuan Chen**, Jing Li, Xiangyu Zhang, Xinyue Li, Maosheng Yao*, Gengfeng Zheng*, Automated in Vivo Nanosensing of Breath-Borne Protein Biomarkers, The 3th China Bioaerosol Conference (November 2018, Xian, China)
3. **Haoxuan Chen**, Maosheng Yao*, #2.BA.13, Development of A High Volume Portable Bioaerosol Concentrating Sampler, AAAR 36th Annual Conference (October 2017, Raleigh, USA)
4. **Haoxuan Chen**, Maosheng Yao*, #S7-0003, Rapid respiratory pathogens (*P. aeruginosa; S. aureus*), World Life Science Conference (November 2016, Beijing, China)

DISSERTATION Frame



RESEARCH EXPERIENCES

Investigated characteristic VOCs releasing from living rats exhaled breath when exposed to different airborne toxicants:

- Living rats emitted distinctive profiles of volatile organic compounds (VOCs) via breath when exposed to various airborne toxicants such as endotoxin, O_3, ricin, and CO_2 within minutes.
- Compared to background indoor air, when exposed to ricin or endotoxin aerosols breath-borne VOC levels, particularly carbon disulfide, were shown to decrease, while elevated levels were observed for O_3 and CO_2 exposures.
- A clear contrast in breath-borne VOCs profiles of rats among different toxicant exposures were observed with a statistical significance.
- MicroRNA regulations such as miR-33, miR-146a and miR-155 from rats' blood samples also suggested varying mechanisms used by the rats in combating different air toxicant challenges.

Significance: The fundamental science here helps to monitor comprehensive air toxicity without the need of detecting specific species.

Investigated response and regulating mechanism of rats to PM from different countries with different toxicity via toxicological experiments:

- Acute health effects were triggered after the PM extraction injection including immune and inflammatory responses with up-regulated serum biomarkers, increased leucocytes and hemorrhage in alveoli.
- Overall, the PM samples from San Francisco and Zurich appeared to be more toxic than those from Johannesburg and Beijing.
- Down-regulation of microRNAs (i.e., miR-125b and miR-155) triggered a "brake release" effect in the PM-induced inflammation, leading to a cascade of inflammatory mediators.
- The miR-125b and miR-21 were found to be most sensitive to the PM exposure, surprisingly exhibiting a negative dose-response type relationship with source-specific PM toxicity (r^2=0.63 and 0.57).

Significance: The results here indicate that source-specific PMs could induce different health effects by regulating different mi-RNAs. Our findings also suggest that a group of microRNAs, e.g., miR-125b and miR-155, can be externally mediated to neutralize PM-related damages.

Developed a system for automated *in vivo* nano-sensing breath-borne protein biomarkers

- A system called dLABer (Detection of Living Animal's Exhaled Breath Biomarker) that integrates living subjects, breath sampling, microfluidics, and biosensor for real-timeautomated tracking the breath-borne biomarkers.
- The dLABer was able to online detect and report the differences among breath-borne inflammation agent interleukin-6 (IL-6) levels from rats injected with different ambient particulate matters (PMs).
- The dLABer system were shown to have an up to 10^4 higher signal-to-noise ratio compared to the enzyme-linked immunosorbent assay (ELISA) when analyzing the same breath samples.
- The blood-borne IL-6 levels analyzed using ELISA from the different PM-injected rats and the PM toxicity by dithiothreitol (DTT) also agreed well with those breath-borne results from the dLABer system.
- Video recordings further verified that rats exposed to PM with higher toxicity (DTT) as revealed by the dLABer appeared to be less physically active.

Significance: the dLABer system is capable of real-time non-invasively monitoring breath-borne biomarkers with a substantially higher signal-to-noise ratio. The dLABer system developed here is expected to revolutionize the pollutant health effects studies, bed-side disease diagnosis as well as physiological condition monitoring on a single protein level.

Developed and evaluated a high-flow portable biological aerosol trap (highbiotrap) for rapid microbial detection

- A portable high volume bioaerosol sampler named as HighBioTrap was designed and evaluated, operating at a flow rate of 1200 L/min, with an impaction velocity of 10.2 m/s.
- The HighBioTrap has a cutoff size of ~ 2 μm and physical collection efficiencies of 10% and 20% for *Pseudomonas fluorescens* and *Bacillus subtilis* bacterial particles, respectively.
- The HighBioTrap was shown to obtain a higher microbial diversity than the BioStage impactor for both in outdoor and indoor environments given the same sampling time ($p<0.01$), despite the higher desiccation effects introduced by higher flow rate.
- Most of the desiccation effects might have occurred between 3 and 5 minutes of the sampling and an impaction velocity of around 10 m/s might be a close-to-optimal impaction velocity for collecting most environmental bacteria while maximally preserving their culturability.

Significance: This work contributes to our understanding of microbial sampling stress (impaction velocity and sampling time), while developing a portable high-volume sampler. The HighBioTrap sampler could find its great efficiency for bioaerosol detection in terms with qualitative microbial analysis, such as investigation of microbial aerosol diversity for a particular environment, or when the low level of pathogens is present and detection time is of great concern.

Detected Biological Particles in Exhaled Breath of Patients with Respiratory Infection

- A non-invasive protocol for pathogen detection using an emerging technology termed as loop-mediated isothermal amplification (LAMP) and exhaled breath was developed.
- The detection limit (genomic DNA concentration) of LAMP was as low as 0.1 pg/μl for *P. aeruginosa* and 1 pg/μl for *S. aureus*.
- The LAMP outperformed qPCR in terms with detection rates and sensitivity regardless of pure and spiked samples for both pathogens tested (p-values<0.05) for most tested scenarios.
- The sensitivity of the LAMP method was less impacted by human samples than the qPCR especially when pathogens were in low quantities.

Significance: Use of the EBC when combined with the LAMP could produce similar detection rates compared to the use of throat swabs. In future, portable and inexpensive LAMP-EBC based devices could be developed for rapid point-of-care diagnosis as well as high throughput screening for respiratory infection.